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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This document provides guidance and procedures for performance testing airborne communication equipment. The document addresses the following: (1) Communication Range, (2) Transmission Pattern, (3) Homing, (4) Retransmission, Effects of Atmospheric Conditions, and (5) Durability. It provides the test project officer with general information and guidance in test preparation, test controls, test conduct and data reduction.			

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US ARMY TEST AND EVALUATION COMMAND TEST OPERATIONS PROCEDURES

DRSTE-RP-702-105

*Test Operations Procedure 6-3-025

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AD No

FUNCTIONAL TESTING COMMUNICATION EQUIPMENT (AVIONICS)

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1. SCOPE. This TOP establishes the procedures to conduct functional development testing of aircraft communications equipment, particularly communication systems (radio) utilized to allow the transfer of information either between aircraft or between aircraft and ground positions. The transfer of information includes various modes of operation including voice communication, homing retransmission which circumvents line-of-sight and range restriction, and coded transmission (continuous wave, telemetry, multiplexing, etc.). Any given system may allow operation in one or more of these modes. The technical characteristics vary primarily in the techniques utilized for modulation; e. g., amplitude modulation (AM), frequency modulation (FM), and single side band (SSB). The antenna pattern is not a test measurement of the operational flexibility of the communication equipment; however, the antenna pattern does have a bearing on the operational flexibility of a communication system and must be known to effectively accomplish the functional test. The procedures for establishing antenna patterns are contained in this document, although they need not be used when the antenna pattern for a particular antenna and aircraft configuration is known. The *This TOP supersedes MTP 6-3-025, Avionics, Communications Equipment,

MTP 6-3-024, Survival Radios; and supplements MTP 6-3-020, Antennas, General.
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scope of this document is sufficiently broad and the test procedures, by design, are general enough to accommodate testing of new communication technology and the redesign of existing equipment due to changes in aircraft configuration and tactical operation.

2. FACILITIES, EQUIPMENT, INSTRUMENTATION, AND SUPPORT REQUIREMENTS.

Functional developmental testing of aircraft avionic and communication systems will be accomplished within the aircraft environment of the designated aircraft type and configuration for which the avionic/communication equipment was developed, and in accordance with all Army maintenance and operational scenarios established for the designed aircraft and avionic/communication systems. The facilities, instrumentation, and support equipment required to support the developmental test should be defined in the Test Design Plan (TDP) or the Maintenance Support Plan (MSP); however, if this data is not available, the following facility characteristics, support, and instrumentation requirements should be addressed as a minimum to support the evaluation of all developmental criteria presented in the appropriate requirement documents (LR, LOA, ROC, MN, etc.).

2.1 Facility.

CHARACTERISTICS

MINIMUM REQUIREMENTS

Operational airfield

As required to support test aircraft.

Communication facility

Capable of receiving and interrogating the airborne communication equipment.

Airspace

As appropriate to conduct test.

Maintenance support

As required to support aircraft and test equipment.

Instrumentation/avionics facility

As required to support test.

Data reduction facility

As required to support data reduction.

2.2 Equipment.

Maintenance support

Standard Army tool set.

Photographic/Video

Color camera (motion, still), as required.

Appropriate aircraft and aircraft support equipment

As required.

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CHARACTERISTICS

MINIMUM REQUIREMENTS

Meteorological equipment

As required.

Equipment required by referenced
TOP's

As required.

2.3 Instrumentation. As required.

2.4 Support Requirements.

2.4.1 Personnel.

Photographic

As required.

Instrumentation

As required.

Data reduction

As required.

Maintenance(avionics, aircraft)

As required.

Pilots

As required.

Human Factors Engineer

As required.

2.4.2 References.

a. Army Regulation 70-10, Test and Evaluation During Development and Acquisition of Materiel.

b. Army Regulation 385-16, System Safety.

c. AMC Regulation 700-38, w/TECOM Supplement 1 and USAAVNDTA Supplement 1, Test and Evaluation--Incidents Disclosed During Materiel Testing.

d. DARCOM Regulation 70-8, w/TECOM Supplement 1, DARCOM Value Engineering Program.

e. AMC Regulation 385-12, w/TECOM Supplement 1, Life Cycle Verification of Materiel Safety.

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f. TECOM Regulation 70-23, Research and Development: Equipment Performance Reports (EPR's).

g. TECOM Regulation 70-24, Research and Development: Documenting Test Plans and Reports, w/changes 1 and 2.

h. MIL-C-55163, Calibration of Test and Measuring Equipment.

i. MIL-H-46855, Human Engineering Requirements for Military Systems, Equipment, and Facilities.

j. MIL-S-1472, Human Engineering Design Criteria for Military Systems, Equipment, and Facilities.

k. TOP 1-2-609, Instructional Material Adequacy Guide and Evaluation Standard (IMAGES).

l. TOP 1-2-610, Human Factors Engineering.

m. TOP 6-3-020, Antennas, General.

n. TOP 6-3-506, Durability.

o. TOP 6-3-508, Submersion.

p. TOP 6-3-509, Effects of Weather.

q. TOP 6-3-514, Qualitative Frequency Accuracy and Stability.

r. TOP 6-3-515, Reliable Communication Range.

s. TOP 6-3-517, Electrical Power Requirements.

t. TOP 6-3-521, Operational Intelligibility Testing of Voice Communication Equipment.

u. TOP 6-3-526, Functional Requirements/Aircraft Test Instrumentation.

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- v. TOP 7-3-058, Built-In Test Equipment.
- w. TOP 7-3-059, Diagnostic and Inspection Equipment (Aviation).
- x. TOP 7-3-500, Physical Characteristics (Aviation Materiel).
- y. TOP 7-3-501, Personnel Training.
- z. TOP 7-3-502, Installation Characteristics.
- aa. TOP 7-3-503, Arrival Inspection/Pre-Operational Inspection (Aviation Materiel).
- bb. TOP 7-3-506, Safety.
- cc. TOP 7-3-507, Maintenance (Maintainability/Availability).
- dd. TOP 7-3-508, Reliability (Aviation Materiel).
- ee. TOP 7-3-509, Compatibility/Related Equipment (Aviation Materiel).
- ff. TOP 7-3-519, Photographic Coverage.
- gg. TOP 7-3-530, Vulnerability and Security (Aviation Materiel).
- hh. Requirements documents (LR, LOA, ROC, Materiel Needs, etc.).

3. PREPARATION FOR TEST. This section provides guidance for planning a functional developmental test of aviation communication equipment. Consummate the planning phase with the detailed test plan. The test plan will establish the test methodology and provide the procedures for gathering and reducing data to accommodate each developmental test objective. The test plan will also identify all facility, instrumentation, equipment, and support requirements including any specialized training requirements. Follow the appropriate test planning steps as outlined below to insure a complete, thorough, and cost-effective test.

3.1 Review. Review all pertinent data related to the materiel development test.

- a. Requirements documents (LR, LOA, ROC, Materiel Needs, etc.).
- b. TECOM Independent Evaluation Plan/Test Design Plan (IEP/TDP).

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- c. Applicable materiel available from the procuring agency or developer/contractor.
- d. Pertinent reports on previous tests of similar equipment.
- e. Any other applicable source of information (AR's, TOP's, TM, etc.).

3.2 Test Objective. Establish the overall test objectives, as outlined in the TECOM test directive and IEP/TDP. Review the requirements documents for developmental criteria and establish appropriate subtest objectives such as:

a. Initial Inspection. Determine the condition and completeness of the communication system in accordance with TOP 7-3-503.¹ Perform the following as a minimum:

- (1) An inventory check against the basic issue item list (BIIL). Submit an equipment performance report for any discrepancies in accordance with reference 2.4.2 f.
- (2) Remove all protective coverings and preservatives, and inspect for defects.
- (3) Check for completeness of assembly.
- (4) Examine the maintenance support package for completeness, discrepancies, or defects.

b. Physical Characteristics. Determine the physical characteristics of the communication equipment in accordance with TOP 7-3-500.² Perform the following as a minimum:

- (1) Photograph as appropriate and note the legibility and effectiveness of the test equipment's legends, markings, etc.
- (2) Determine the physical dimensions, weight, and volume of all subsystem components.
- (3) Determine the weight volume of the total system.

c. Installation Characteristics. Determine the installation/removal characteristics of the test equipment in accordance with TOP 7-3-502.³ Perform the following as a minimum:

- 1. TOP 7-3-503, Arrival Inspection/Pre-Operational Inspection (Aviation Materiel).
- 2. TOP 7-3-500, Physical Characteristics (Aviation Materiel).
- 3. TOP 7-3-502, Installation Characteristics.

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- (1) Evaluate the installation instructions for accuracy and completeness.
- (2) Evaluate the installation technique and mounting provisions to protect the test equipment against shock and vibrations, as applicable.
- (3) Evaluate all subsystem, system, or equipment interfaces (plugs, cables, connectors, etc.) for positive response and secure locking.
- (4) Evaluate the system/component installation characteristics for ease and quickness. Assess the following:
 - (a) Accessibility.
 - (b) Mounting flexibility.
 - (c) Quick disconnect design.
- d. Compatibility. Determine if the communication equipment is compatible with each aircraft for which it was designed, compatible with the mission objective of the designated aircraft, and compatible with all other instruments and equipment on the designated aircraft. Do this in accordance with the compatibility TOP 7-3-509.⁴
- e. Performance Test. Determine the adequacy and suitability of the communication equipment to perform its intended function in all applicable operational environments and flight modes in which the designated aircraft is expected to perform. Follow the testing procedures as presented in paragraph 5, Performance Test, this TOP. Pay particular attention to the lighting and HFE considerations. If instrumentation of the aircraft is required to verify the performance sensitivity of the test equipment, see TOP 6-3-526.⁵
- f. Reliability, Availability, and Maintainability (RAM). Evaluate the RAM characteristics of the communication equipment in accordance with TOP 7-3-507⁶ and TOP 7-3-508.⁷
- g. Technical Manuals. Determine the adequacy of the technical manuals in accordance with TOP 1-2-609.⁸

4. TOP 7-3-509, Compatibility/Related Equipment (Aviation Materiel).
5. TOP 6-3-526, Functional Requirements/Aircraft Test Instrumentation.
6. TOP 7-3-507, Maintenance (Maintainability, Availability).
7. TOP 7-3-508, Reliability (Aviation Materiel).
8. TOP 1-2-609, Instructional Material Adequacy Guide and Evaluation Standard (IMAGES).

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h. Personnel Training. Assess the scope of training required to efficiently operate and use the communication equipment under all aircraft flight environments in the designated aircraft mission scenario. Assess any maintenance training required to maintain the equipment. (See TOP 7-3-501)⁹

i. Human Factors. Assess the communication equipment operational characteristics and performance. Assess the following in accordance with TOP 1-2-610.¹⁰

(1) Controls and indicators.

(2) Legends - Effectiveness, visibility, and readability.

(3) Performance - Note traditional operational procedures and system status feedback to the operator, correct response to operational input, auditory and visual characteristics for clarity and distinction.

j. Safety. Identify and evaluate any characteristic of the communication equipment which could lead to a flight safety consideration. Such a condition could result from insufficient or extraneous information as well as critical information grouping/layout or display technique. Insure that all failure modes are fail-safe (see TOP 7-3-506).¹¹

3.3 Schedule. Prepare a detailed test time line depicting each test associated event which must occur to accomplish the test objectives and to insure facilities, logistics, personnel, and support equipment are available in a time frame conducive to accomplishing a comprehensive and cost-effective test. The time line should show sufficient time periods allotted to accomplish each test objective, insuring that adequate amounts of test data are taken to project required statistical confidences to the test results. The following schedule items should be addressed as a minimum.

a. Facility. Schedule the applicable facility requirements presented in section 2.1. Facility requirements associated with adverse flight conditions due to meteorological environmental considerations should not be overlooked. Flights at night and, in particular, under instrument meteorological conditions (IMC), place the greatest demand on the communication equipment.

b. Instrumentation Equipment and Support. Schedule, as applicable, instrumentation support test equipment and support requirements as presented in sections 2.2, 2.3, and 2.4.

9. TOP 7-3-501, Personnel Training.

10. TOP 1-2-610, Human Factors Engineering.

11. TOP 7-3-506, Safety.

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c. Logistics. Schedule logistics requirements, as appropriate, including ground handling equipment, administrative transportation of both personnel and equipment, aircraft fueling, and other servicing accommodations.

3.4 Plan of Test. Develop a detailed test plan in accordance with TECOM Regulation 70-24¹² and IEP/TDP. This plan will provide the test data requirements and the data collection procedures to satisfy each test objective.

3.5 Test Safety. Assess any potential safety consideration for test personnel and equipment. Take appropriate steps (training, safety checklist, posters, etc.) to insure that the safety measures are observed throughout the test. Acquire any test safety releases, as required.

3.6 Environmental Impact. Determine if there are any environmental considerations. If environmental considerations exist, develop procedures or outline precautions to be observed to protect the environment.

3.7 Security. Security safeguards for the United States Government and for the security of the proprietary rights of the test materiel developer must be considered early in the test planning stage. The following steps must be taken:

- a. Consult the TECOM security classification guide for the project, as appropriate.
- b. Consult the primary test agency security representative for security guidance. Coordinate with security personnel of other test support agencies and industry, as appropriate.
- c. Take appropriate security measures throughout the test to safeguard intra-industry proprietary rights and to safeguard the security of Government property.

4. TEST CONTROLS. The developmental communication equipment test will be conducted and test data will be recorded in strict compliance with the TECOM test directive and IEP/TDP. If specific directions are not available, the following guidelines will prevail:

- a. Reduce measurements to universal metric and English units.
- b. Round out numerical observations to the nearest tenth.
- c. Report time to the nearest hundredth of an hour.
- d. Accomplish and record physical characteristics in compliance with TOP 7-3-500.¹³

12. TECOM Regulation 70-24, Research and Development: Documenting Test Plans and Reports, w/changes 1 and 2.

13. TOP 7-3-500, Physical Characteristics (Aviation Materiel).

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e. Calibrate instrumentation and test equipment and have a current calibration certificate for all.

f. Conduct all tests and collect data in compliance with prescribed and/or standard procedures and when deviations are required, justification will be documented.

g. Record and process all data in a timely fashion.

h. Assign only properly trained and qualified personnel to participate in the conduct of the test. In particular, pilot qualifications/capability must reflect the expertise necessary to fly the test flight profiles with precision and safety.

i. Conduct the functional airborne communication test in a test environment representative of the operational environment intended for its use.

j. Conduct each test run under documented conditions, such that the test results could be duplicated or compared.

k. Follow the detailed test plan; document any deviations from same. Avoid non-essential test delay due to aircraft scheduled maintenance. This can be accomplished through coordination and planning.

5. FUNCTIONAL PERFORMANCE TESTS. The objective of this subtest is to outline a series of engineering test procedures which can be used to determine the operational range, clarity, and accuracy of the communication equipment in the aviation environment. The conduct of this subtest will be performed in compliance with the TECOM test directive and IEP/TDP. However, if specific guidance is not available, the following general guidance and specific test methodology will be used to evaluate the functional performance of the communication equipment.

5.1 General Guidance. General guidance establishes certain test procedures common to the functional performance testing of the communication equipment within the scope of this TOP.

a. Determine specific functional characteristics from the test criteria that the test item must demonstrate in the operational environment.

b. Prepare an aircraft flight profile reflecting specific flight modes and characteristics which will exercise each functional characteristic of the communication equipment.

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c. Install and check out the communication equipment in accordance with the installation instructions. Insure input and output signals are within specified limits and that no operational hazards exist.

d. Install, check out, and calibrate test instrumentation as required to record test flight data. Photographs, motion picture, and/or magnetic tape recordings are conventional methods of collecting performance data for comparison and validation purposes.

e. Calibrate all test equipment and instrumentation in accordance with TECOM Supplement to AR 750-25.¹⁴

f. Insure communication and meteorological ground support is available during all flight test phases, as required.

g. Insure adequate data are recorded during each flight to provide credibility as to the clarity and accuracy of the test communication equipment. Subjective interpretations of performance by qualified observers will also be used to evaluate performance.

h. Perform an equipment functional test prior to each test flight and record the following information:

(1) Test run and sequence number description.

(2) Test item nomenclature and serial number.

(3) Functional characteristic of the communication equipment to be evaluated during the particular test run.

(4) Results of equipment functional test.

i. Fly the predetermined flight profile using the test item as the primary communication equipment. Record pertinent flight, meteorological, and communication equipment performance data as required.

5.2 Airborne Communication Equipment.

5.2.1 Operational Characteristics. Verify the following technical properties of the communication equipment, as appropriate.

14. AR 750-25, w/TECOM Supplement 1, Army Metrology and Calibration System.

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a. Power Requirements -- verify the electrical power requirements of the communication equipment. Insure that all requirements are satisfied by the electrical systems of the aircraft on which the test item is installed, and that the communication equipment power requirements do not exceed the allowable limits.

b. Controls, adjustments, and indicators (mechanical and electrical).

(1) For each control, adjustment, and indicator, determine the following, as appropriate.

- (a) Operation is correct.
- (b) Effect on the system is as required.
- (c) Absence of binding and rubbing.
- (d) Calibration is proper.
- (e) Changes are monitored and displayed correctly.
- (f) Range is correct.

(2) List any discrepancies.

(3) Evaluation of devices requiring flight conditions will be checked during the operation and performance demonstration flights.

c. Equipment safety and protective devices -- verify proper operation of each.

d. Fail-Safe Characteristics -- evaluate the system for the following:

(1) Internal failure -- when the system becomes inoperative because of an internal failure, operator personnel shall be made aware of the condition. Simulate failures and verify indication.

(2) Acceptance or provision of external signals -- if the system accepts/provides electrical signals from/to other onboard avionics equipment, operator personnel shall be made aware of any out of limit level existing on any line. Simulate failures on each line and check for indication.

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e. Confidence, self-checking or integrity circuits -- if any, verify proper operation.

f. Primary technical characteristics -- measure receiver sensitivity and transmitter power and frequency (at selected points distributed across the operating frequency range, if applicable.)

g. Cold start and warmup -- subject the system to a minimum of three consecutive cold start power application procedures. Determine warmup time and effect due to multiple power applications.

5.2.2 Performance Test. Perform the following:

a. Check the system for proper operation in all modes for which it is designed. Conduct test utilizing various types of aircraft involved in air-to-ground and air-to-air communications procedures. Plan the procedures so that the system under test is netted against various types of existing communication systems in addition to an evaluation involving communications between aircraft similarly equipped. Particular attention shall be paid and noted to any problems, e.g., noise, fading or intermittent signal, poor intelligibility encountered during all procedures. Utilize all controls and various frequencies to determine their effectiveness.

b. Accomplish speech intelligibility test in accordance with the Modified Rhyme Test as presented in Human Factors Engineering TOP 1-2-610.¹⁵ Assure that the background noise and sound pressure levels reflect the operational environment of the test equipment.

5.2.3 Communications Range -- Air-to-Ground. Perform the following:

a. Fly the aircraft at various altitudes to the maximum practical range for the system from an omnidirectional transmitting ground station.

b. Attempt communications with the system operating at various frequencies over its band. Include at least one high, one low, and one median channel. Note channel changing time required and difficulties in reestablishing communications.

5.2.4 Transmission Pattern. Perform the following:

a. Maneuver the aircraft through procedures which present the aircraft in different profiles to the ground station utilizing an altitude which affords good transmission and approximately at the maximum practical range.

15. TOP 1-2-610, Human Factors Engineering.

b. Note and record any configurations in which communication is lost or becomes unintelligible.

5.2.5 Range Pattern/Homing. Perform the following:

a. Proceed inbound to the station, using a median altitude and starting from the maximum practical range.

b. Maintain communications while inbound noting particularly any inability of the system to provide automatic gain control with increasing signal strength.

c. Utilize the capability of systems provided with a "homing" mode of operation while inbound and outbound for directional navigation. Note the error in direction and difficulties of display interpretation.

5.2.6 Air-to-Air/Retransmission. Perform the following:

a. Determine the ability of the system to provide air-to-air communications by having similarly equipped aircraft conduct various flight patterns with respect to each other while maintaining communications. Include the following:

(1) Straight line approaches and departures.

(2) Aircraft at different altitudes, at various ranges with respect to each other and either approaching or receding.

b. Check the capability where the system provides for a "retransmission" mode, by having two aircraft operate over a test range which includes two ground stations separated by approximately twice the maximum range. Have the ground stations communicate through the aircraft and note the effectiveness of this system mode.

5.2.7 Simulated Tactical Mission. The use of the communication system during field operations shall be evaluated by the following:

a. Utilize aircraft equipped with the test system in simulated tactical operations.

b. During the operation, have the aircraft provide for surveillance, etc., while communicating with ground forces. Insure that the system is utilized in communications with similar types of communication equipment utilized by ground forces including all mobile (vehicle mounted), portable (man-carried), and large ground systems such as those used for landing and traffic control at temporary airfields.

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5.2.8 Effects of Atmospheric Conditions. Selected performance procedures shall be conducted during periods of atmospheric change to determine the effects of the change on transmission, reception, day or night displays, and other performance characteristics. These periods and/or conditions will include:

- a. Night hours.
- b. Hours at sunrise and sunset.
- c. Poor weather conditions, poor visibility (rain, fog).
- d. High and low temperatures existing during the test period.
- e. Operation to the maximum operative altitude of the equipment or aircraft within practical limits.

5.2.9 Durability. On completion of the operation and performance tests, the durability characteristics of the system will be examined. Perform the following:

- a. A visual inspection with consideration given to the following:
 - (1) Loose chassis components.
 - (2) Loose or missing hardware.
 - (3) Broken fasteners or seams.
 - (4) Discoloration due to heat effects, rust, or corrosion.
 - (5) Loose panel components.

For each defect, the nature and location shall be noted.

- b. A remeasurement of primary technical characteristics to determine any degradation (transmitter power, receiver sensitivity).
- c. An examination of equipment failures isolating those that are attributed to lack of durability.

5.2.10 Data Required. Record and time correlate the following:

a. Flight profile information to include test run sequence number and profile description.

b. Meteorological conditions during each test run; i.e., temperature, relative humidity, atmospheric pressure, windspeed and direction, precipitation, and other characteristics.

c. Test engineering data:

(1) Flight performance data; airspeed, altitude, attitude, rate of climb/descent, and bank angle.

(2) Time marked to known reference.

(3) Photographic data.

(4) Aircraft to ground transmissions.

(5) Communication equipment performance data.

d. Subjective data.

5.3 Survival Radios.

5.3.1 Discussion. The survival radio is utilized to alert rescue personnel of an emergency situation and as an aid in locating personnel in distress. Survival, following a forced landing or crash of an aircraft on land or at sea, is often dependent upon how quickly rescue is effected. Effective radio communication represents the best means of aiding in a rescue operation.

5.3.2 Operational Characteristics. Verify the following technical properties of the survival radio as appropriate.

a. Power Requirements --Verify the electrical power characteristics of the survival radio in accordance with TOP 6-3-517.¹⁶ Insure that the power requirement satisfies the requirement documents and is a suitable power source for the mission scenario presented in the MN document.

16. TOP 6-3-517, Electrical Power Requirements.

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b. Controls, adjustments, and indicators (mechanical and electrical).

(1) Determine the following for each control, adjustment, and indicator, as appropriate.

- (a) Operation is correct.
- (b) Effect on the system is as required.
- (c) Absence of binding and rubbing.
- (d) Changes are monitored and displayed correctly.
- (e) Range is correct.

(2) List any discrepancies.

(3) Check characteristics requiring flight conditions to evaluate during the operation and performance test.

c. Equipment Safety and Protective Devices -- verify proper operation of each.

d. Fail-Safe Characteristics -- evaluate the system for the following:

(1) Self-Test -- when the system/subsystem becomes inoperative, operator personnel shall be made aware of the condition. Simulate failures and verify indication.

(2) Redundancy -- circuitry, subsystems; verify any automatic switching capability by simulating failures.

e. Primary Technical Characteristics -- measure receiver sensitivity and transmitter power and frequency (at selected points distributed across the operating frequency range, if applicable).

f. Cold Starts and Warmup -- subject the system to a minimum of three consecutive cold start power application procedures. Determine warmup time and effects due to multiple power application.

5.3.3 Submersion. Determine the water immersion resistance characteristics of the survival radio in accordance with TOP 6-3-508, Submersion.¹⁷

5.3.4 Effects of Weather. Evaluate the survival radio under applicable weather conditions as presented in TOP 6-3-509, Effects of Weather.¹⁸

5.3.5 Performance Test. Evaluate the functional performance of the survival radio as a function of reliable range, voice intelligibility, frequency accuracy, and stability.

a. Reliable Range. Operate the survival radio in areas typical of those for which it was designed (also, operate from within simulated "downed" aircraft), and determine its reliable communication and homing range by locating, communicating with, and homing to the homing signal emitted by the radio. To determine the maximum reliable range of the test radio, use the procedures of TOP 6-3-515¹⁹ as a guide and proceed as follows:

(1) Establish communication between a rescue aircraft and the survival radio operator.

(2) Operating the survival radio in the normal transmit mode, have the rescue aircraft proceed from over the survival radio location outbound on a cardinal heading. The aircraft altitude versus slant range from the survival radio ground position for line-of-sight communication can be determined by the equation $NM = \sqrt{A}(1.23)$. NM=Nautical Miles slant range and A=Altitude in feet. Appendix C contains a graph of this relationship.

(3) Exercise the airborne equipment and survival radio equipment jointly in the various operational modes/codes while observing the equipment for maximum range at which loss of signal occurs.

(4) Have the aircraft reverse course and proceed inbound until the survival radio signals are observed.

(5) Repeat procedures 2, 3, and 4 above, observing signal quality in the vicinity of the survival radio and at the range where signal loss occurs.

(6) Execute 360° turns on random headings and at arbitrarily selected ranges to determine homing and range reliability. Conduct the test at gradually increasing ranges to determine the effect of range on homing reliability and reception.

17. TOP 6-3-508, Submersion.

18. TOP 6-3-509, Effects of Weather.

19. TOP 6-3-515, Reliable Communication Range.

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b. Voice Intelligibility. Determine the quality of voice intelligibility relative to range using the Modified Rhyme Test as presented in TOP 1-2-610.²⁰ Background noise and sound pressure levels should reflect the operational environment of the test equipment.

5.3.6 Durability. Evaluate the durability of the survival radio in accordance with TOP 6-3-506, Durability.²¹

5.3.7 Data Required. Record and time correlate the following:

a. Flight profile information to include test run sequence number and profile description.

b. Meteorological condition during each test run, i.e., temperature, relative humidity, atmospheric pressure, wind speed and direction, precipitation, and other characteristics.

c. Test engineering data:

(1) Flight performance data; airspeed, altitude, attitude, rate of climb/descent, and bank angle.

(2) Time marked to known reference.

(3) Photographic data.

(4) Aircraft to ground transmissions.

(5) Survival radio performance data.

(6) Subjective data.

5.4 Antennas (Aviation).

5.4.1 Discussion. This section will supplement TOP 6-3-020, Antennas, General,²² to include procedures for determining the antenna pattern unique to aviation. "General.

20. TOP 1-2-610, Human Factors Engineering.

21. TOP 6-3-506, Durability.

22. TOP 6-3-020, Antennas, General.

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An effective measurement of the radiation pattern can only be accomplished if the variables affecting the data are held to a minimum. Variables such as weather, normal equipment instability, and exact orientation of ground measurement antennas cannot readily be completely controlled and for the purposes of this TOP, are considered negligible. The controllable variables, such as operator technique, flight technique, data recording, and data presentation, must be held to a minimum."

5.4.2 Performance Procedure.

5.4.2.1 Airborne Station.

a. General. Flight for the purpose of conducting antenna radiation patterns must be performed over a predetermined ground fix. The ground fix should be recognizable from an altitude of 2,500 feet and be in an area of sparse air traffic.

b. Personnel. The aircraft conducting the antenna patterns should contain two persons; one to fly the aircraft, the other to act as safety observer.

c. Operation.

(1) Upon arrival at the established ground fix, the pilot will maintain one flight level (normally 2,500 feet MSL) and establish radio contact with the ground station on a test frequency, and inform the ground crew that he is ready to initiate the test. The pilot, upon arriving over the ground fix, straight and level, on a heading of 360° will:

(a) Call "360 Mark."

(b) After passing the fix, he will hold the heading for approximately 30 seconds and execute a 15° teardrop turn to the right to a heading of 195° .

(c) The pilot should have the aircraft on the proper heading 10 seconds prior to passing over the fix in order to alert the ground crew.

(d) Over the fix, he will call "195 Mark," hold heading approximately 30 seconds, and execute another teardrop to the right to a heading of 30° .

(e) By making continuous right-hand 15° teardrop turns, the pilot will fly all headings, multiple of 15° , FROM the fix, as shown in the following table. (For further reference, see Figure 2, Appendix C, Flight Courses for Antenna Radiation Patterns.)

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<u>LEG</u>	<u>TRUE MG HEADING</u>	
1	360	
2	195	
3	030	
4	225	
5	060	
6	255	
7	090	
8	285	
9	120	
10	315	
11	150	
12	345	CLOVERLEAF PATTERN 15° INTERVALS
13	180	
14	015	
15	210	
16	045	
17	240	
18	075	
19	270	
20	105	
21	300	
22	145	
23	330	
24	175	

NOTE: The pilot must alert the ground crew as he approaches the fix and call "Mark" for each heading.

(2) After completion of the patterns for straight and level flight, patterns will be conducted with the aircraft in a standard rate turn to the right and in a standard rate turn to the left. After notifying the ground crew, the pilot will initiate a standard rate turn from a heading of 360° with his mike keyed. The pilot will call off each 15° increment in the turn, e. g., "015 Mark," "030 Mark," etc.

NOTE: Separate patterns will be conducted throughout the range of the tested equipment. If available, three frequencies, one each from the low, medium, and high portions of the tested equipment's frequency range.

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d. Bench Check. The equipment to be tested will be thoroughly bench tested in accordance with applicable TM prior to the flight test.

5.4.2.2 Ground Station.

a. General. The ground station utilized can be either mobile or stationary. The field intensity measurement equipment (AN/URM-85 or equivalent) will be the same for either station.

b. Operation Instructions. The Noise and Field Intensity Meter will be operated in accordance with the following:

(1) Preliminary Adjustments. The following steps comprise the preliminary setup and adjustments that must be made prior to taking any radiation measurements:

(a) Set the controls to the positions indicated.

<u>Control</u>	<u>Position</u>
Power	Off
Function Switch	Meter Balance
Impulse Gen. P. R. R.	X100
Cycles	10
Sine Wave Oscillator Impulse Gen. Switch	Off
Slideback	Maximum cw
I. F.	Maximum cw
Volume	Maximum cw

(b) Check tuning unit for required frequency range (1 of 4 tuners covering from 20 mc to 1000 mc).

(c) Turn power on. Allow five minutes warmup.

(d) Connect the tuning unit to the attenuator output connector by means of the 6 inch patch cord.

(e) Connect one 18 inch patch cord from the Signal Input Connector on the main unit to the Signal Input Connector on Switching Unit, SU-105.

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(f) Connect the other 18 inch patch cord from the Impulse Generator Connector on the main unit to the Impulse Generator Connector on Switching Unit, SU-105.

(g) Connect the 30 foot cable assembly (CB-105) to the connector on the Switching Unit marked "From Antenna."

(h) Adjust meter balance control with the function switch in "Meter Balance" position for zero reading on the large meter.

(i) Change function switch to "Zero Adjust" position and turn the zero adjust until meter again reads zero. Repeat Steps h and i until meter remains at zero.

(j) Turn to peak and set I. F. gain control to approximately 3/4 of its fully clockwise position.

(k) Turn on Impulse Generator and plug in earphones.

(l) Set toggle switch on switching unit (SU-105) to "Calibrate" position.

(m) Adjust "Fine Contact Adjust" for a clean tone and turn off impulse generator.

(n) Connect the loose end of the 30 foot antenna cable to the proper antenna (dependent upon frequency). Antenna will be erected in a vertical position toward the pre-determined ground fix.

(o) Set function switch to "Peak" with toggle switch on switching unit to "Calibrate" position.

(p) Adjust IF gain control with impulse generator on, until pointer lines up with "Cal Mark" on large meter.

(q) Adjust impulse generator output attenuator (pull to turn) to maintain the pointer in the lower one-third of the meter scale.

(r) Set toggle switch on switching unit to "Read" position and function switch to "Carrier."

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(s) With an input signal, adjust tuning control on tuning unit for maximum meter deflection on large meter. It may be necessary to change the signal input attenuator setting in order to achieve an "on scale" meter reading. Set signal input attenuator to facilitate easier reading of the meter and use this setting as a reference throughout the test.

c. Recording.

(1) Record the collected data on a locally prepared form. (See attached Antenna Radiation Pattern Data Sheet, Appendix B) If desired, this data could then be transferred to a polar graph by the project engineer.

(2) Two persons are required for recording the data. One person will assimilate the data while the other is recording it.

(3) The DB setting of the signal input attenuator will be recorded and used as a reference. This reference will be used throughout the test, if feasible. If the reference has to be changed during the test, the change will be recorded in the "Remarks" column of the Data Sheet.

(4) The headings shown on the Data Sheet will be the magnetic heading of the aircraft and the relative bearing of the ground station from the nose of the aircraft.

5.4.3 Data Required. Field strength (DB) versus aircraft/antenna orientation to the field strength meter. See Antenna Radiation Pattern Data Sheet, Appendix B.

6. DATA REDUCTION AND PRESENTATION.

6.1 Data Reduction. Identify, organize, and correlate raw test data as to time, parameter grouping, and test run. As required, convert raw test measurements to engineering units. Analyze the performance data for the aircraft instrument to satisfy the test objectives and determine compliance or noncompliance with the test instrument developmental criterion or specifications.

6.2 Data Presentation.

a. Prepare a narrative document of the test results to include diagram, graphs, photographic, tabular, and other reduced data, as required, to support the test conclusions and recommendations. The degree to which the test item satisfies the test criteria or specifications in the operational environment should be clearly evident.

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b. In the instance of a total or partial failure of the test item to perform its intended function, assess the implications of the failure and present recommendations as applicable.

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APPENDIX A-1

PRETEST CHECKLIST

FUNCTIONAL TESTING COMMUNICATION EQUIPMENT

1. Have facilities, test equipment, instrumentation, and support requirements been scheduled or secured? See paragraphs 2 through 2.4.2, this TOP. Yes _____
No _____.
2. Has appropriate test planning been accomplished in accordance with paragraphs 3.1 through 3.7, this TOP? Yes _____ No _____.
3. Have test control measures been implemented such that test results could be duplicated or compared? See paragraphs 4a through 4k, this TOP. Yes _____
No _____.

APPENDIX A-2

POST-TEST CHECKLISTFUNCTIONAL TESTING COMMUNICATION EQUIPMENT

1. Have test data been collected, recorded, and presented in accordance with this TOP? Yes _____ No _____. Comment: _____.
2. Were the facilities, test equipment, instrumentation, and support accommodations adequate to accomplish the test objectives? Yes _____ No _____. Comment: _____.
3. Have all data collected been reviewed for correctness and completeness? Yes _____ No _____. Comment: _____.
4. Were the test results compromised in any way due to insufficient test planning? Yes _____ No _____. Comment: _____.
5. Were the test results compromised in any way due to test performance procedures? Yes _____ No _____. Comment: _____.
6. Were the test results compromised in any way due to test control procedures? Yes _____ No _____. Comment: _____.
7. Were the test results compromised in any way due to data collection, reduction, or presentation technique? Yes _____ No _____. Comment: _____.

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APPENDIX B

DATA COLLECTION FORM

FUNCTIONAL TESTING COMMUNICATION EQUIPMENT

SAMPLE

I. Date _____ Aircraft Tail No _____.

II. Test Run Identification _____ Profile No _____.

III. Test Item Identification.

Nomenclature

Model No

Serial No

IV. Data Collection Technique. _____

_____.

V. Data Parameters Being Recorded.

1.

2.

3.

..

..

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VI. Maximum Operational Range (as applicable).

Slant Range NM	Altitude Feet	Operational Utility			Comments
		Good	Marginal	Not Accept.	

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VII.

ANTENNA RADIATION PATTERN DATA SHEET

Type of Antenna Pattern _____ Frequencies (1) _____ (2) _____ (3) _____
Type of Antenna _____ Location of Antenna _____
Location of Ground Sta. _____ Distance to Ground Sta. _____
Location of A/C _____ Flight Altitude _____ Flight Altitude _____
Type & No of A/C _____ Type of Ground Equip. Used _____
Type of Airborne Equip. Used _____ Signal Input Atten. (Ref.) _____ DB
Date _____ Project No _____ Weather _____

Mag. Heading	DB	Relative Bearing	Remarks
0			
15			
30			
45			
60			
75			
90			
105			
120			
135			
150			
165			
180			
195			
210			
225			
240			
255			
270			
285			
300			
315			
330			
345			

Ground Sta. Operator _____

Airborne Sta. Operator _____

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VIII. Test Run Atmospheric Conditions.

1. Ambient temperature_____.
2. Relative Humidity_____.
3. Atmospheric Pressure_____.
4. Precipitation_____.

IX. Observer/Operator Comments Including:

1. Commenter identification_____Test Responsibility_____.
2. Test item utility.
3. Advantages/disadvantages.
4. Operational complexity.

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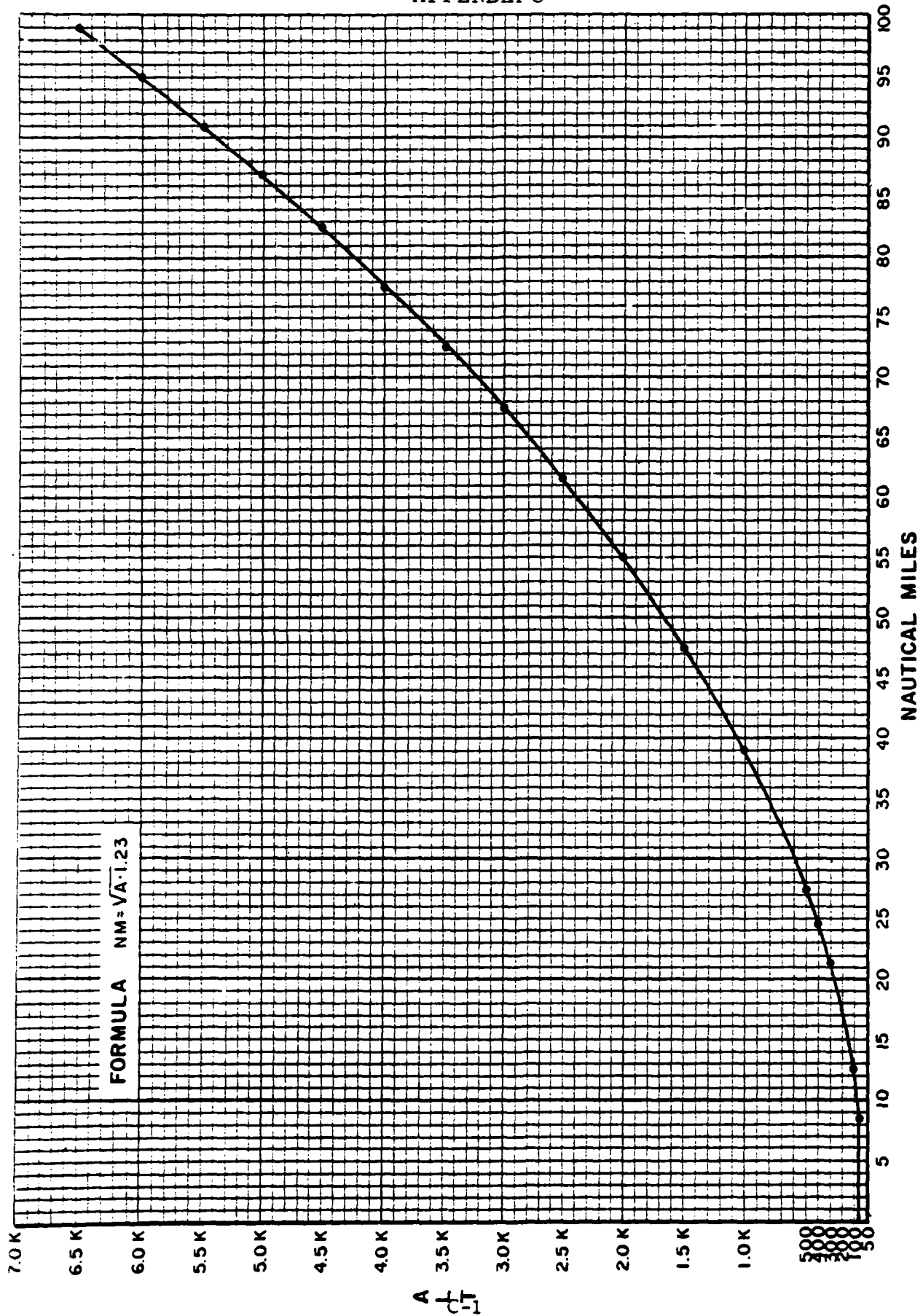
X. Test Incident Narrative Description Including:

1. Observer/narrator identification _____.
2. Test event time line surrounding incident.
3. Pertinent circumstances surrounding incident.
4. Pertinent environmental, flight, or test parameter changes surrounding the incident.

XI. Test Personnel.

Name	Title	Test Function	Comments Experience
1.			
2.			
3.			

APPENDIX C



VHF LINE OF SIGHT GRAPH
Figure 1

APPENDIX C

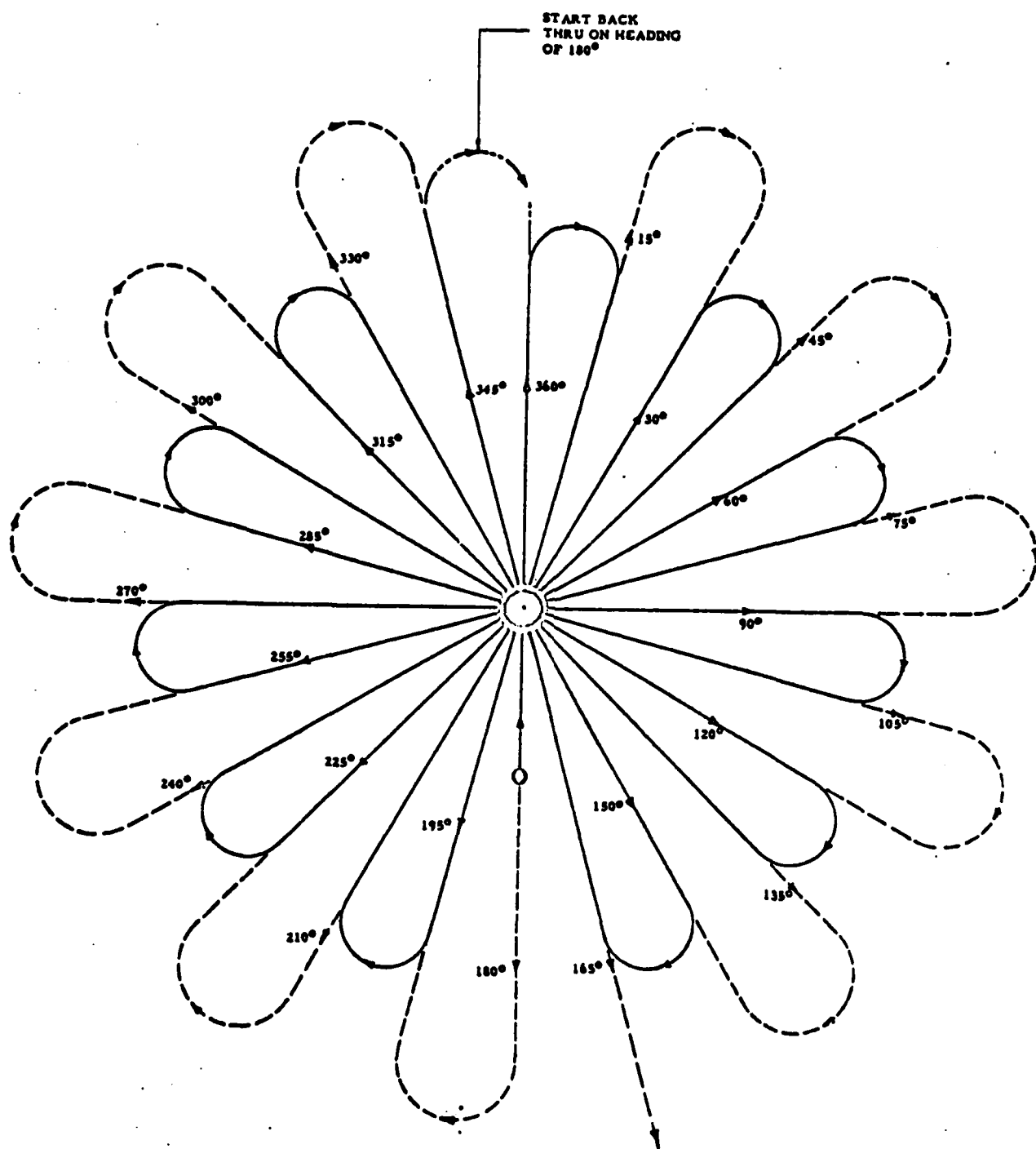


FIGURE 2
FLIGHT COURSES FOR
ANTENNA RADIATION PATTERNS

DATE
FILMED
-8